Common Fabric Dyes Promise to Help Optical Communications

Researchers at the Virginia Polytechnic Institute and State University have found a way to use common fabric dyes to make optical communications faster and less expensive.

The scientists employed a thin film of Procion Red, commonly used in tie-dyed T-shirts, to make an electro-optical modulator, a key element in optical systems.

Optical devices traditionally use electrical signals to turn light sources on and off and thereby convey data via binary one and zero values. The rate at which a system can turn the light on and off determines the data flow. However, the traditional approach yields data rates of only about 10 GHz, explained Virginia Tech's Randy Heflin, associate professor of physics.

Another approach leaves a laser on continuously but makes the signal appear to go on and off with an electro-optical modulator.

These systems split a light beam into two streams traveling roughly in parallel. When the modulation system applies electricity to the part of the system that handles one of the streams, the material's refractive index changes and slows the light's speed. When the system recombines the two pieces into one beam, the light is out of phase and thus appears to be off.

Some of these systems use lithium niobate as the key material, Heflin said, but they can't work faster than 40 GHz. Organic materials, though, like Procion Red, can transfer data at about 100 GHz (about 100 Gbits per second), he explained.

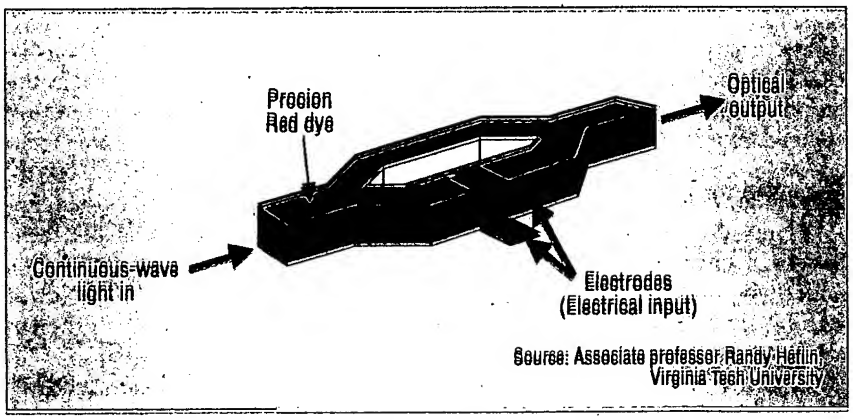
The dye-based electro-optical system is also less expensive than systems using other materials, said Heflin. The cost is lower because the Procion Red-based process eliminates the steps—such as crystallization or heating—needed to align molecules in substances such as lithium niobate. Molecule alignment makes the substances function properly as electro-optic modulators.

One issue challenging researchers is the amount of voltage necessary for modulation. This determines how much power the system consumes and how difficult and expensive it is to design the electronics.

The Procion Red system currently requires about 10 volts, while lithium niobate modulators need only about 3 volts. However, said Heflin, "We are confident we can decrease the voltage in the next year or two."

According to Heflin, the Virginia Tech research team is studying a number of related issues, and until they are resolved, commercialization must wait perhaps three years. ■

—Linda Dailey Paulson



Researchers have developed an electro-optical modulator that works with Procion Red dye, commonly used in tie-dyed T-shirts, to make optical communications systems faster and less expensive. At times, the system splits an incoming laser beam into two streams traveling in parallel. When the system applies electricity to the part of the system handling one piece, the dye slows the light's speed. When the system recombines the two pieces into one beam, the light is out of phase and appears to be off. At other times, the system lets the light through uninterrupted. This system thus can convey data via binary one and zero values.

FIG. 1

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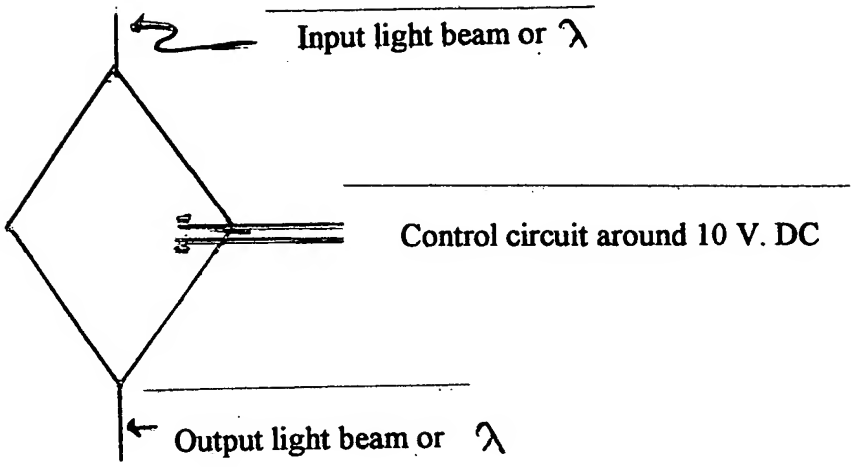
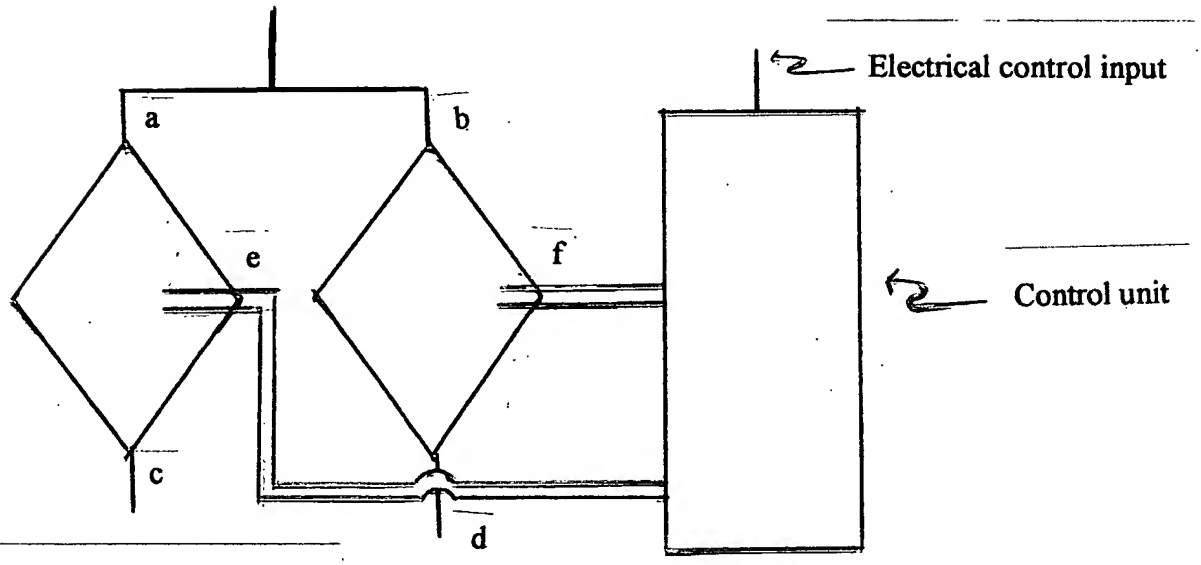


An electro-optical on/off switching process

FIG. 2



a and b light beam or λ inputs

c and d light beam or λ outputs

e and f electrical control circuits

Electro-optical light beam or λ switching process

FIG. 3